Allen-Bradley

Technical Data

SLC 500™ RTD/Resistance Input Modules

(Catalog Numbers 1746-NR4 and 1746-NR8)

1746-NR4

1746-NR8

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The RTD/Resistance Input Modules enhance the present temperature control capabilities of your SLC 500™ system by providing the capability to interface with 12 different types of RTDs and four different direct resistance ranges. RTDs are known for their accuracy, repeatability, linearity and long-term stability. The modules' RTD sensor combination is easy to install and provides greater output (ohms/°C or ohms/°F), accuracy, linearity and repeatability with temperature, as compared to other methods of temperature measurement/control. Each channel accepts different types of RTD inputs (for example, platinum, nickel, copper, and nickel-iron) and accepts resistance devices like potentiometers. The modules convert RTD input to temperature (°C,°F) and convert resistance device input to ohms.

Two modules are available, giving you the choice between the 4-channel 1746-NR4 and the 8-channel 1746-NR8 module.

Both modules provide channel configuration flexibility that allows you to define the operational characteristics for each input channel via your ladder logic programming. There are no hardware DIP switches to set. Each channel is configured using your ladder program and may be dynamically reconfigured without handling the hardware. The modules perform on-board scaling to engineering units. For example, you can specify RTD or resistance device input, temperature resolution in degrees or tenths of a degree Celsius or Fahrenheit, and resistance device resolution in ohms, tenths of an ohm and one-hundredth of an ohm. In addition to engineering units, you can format conversion of the input data to proportional counts or scaled-for-PID.

The choice of four filter frequencies permits you to select input noise filtering appropriate to the application and surrounding environment. 50Hz and 60Hz noise can be filtered from the input signal for greater noise rejection and resolution. For applications where system response speed is critical, minimum filtering can be selected to reduce the time it takes a step change at the input to be made available to the SLC 500 controller.

User calibration is not required. Each channel undergoes a calibration cycle at power-up, on channel configuration, or on your command to compensate for module component drift. This enhances module accuracy and saves valuable service time and money. The 1746-NR8 module can also be configured to perform an autocalibration cycle every five minutes.

Fault diagnostics check for open circuits, short circuits or out-of-range values; then indicate operational problems on status LEDs. Channel status LEDs and diagnostic bits signal you if input channel data is out of range or if an open-circuit or short-circuit condition is present. Channel configuration validity is also checked. In addition, a module status LED differentiates recoverable channel errors from more serious module-related problems, saving you troubleshooting time and money.

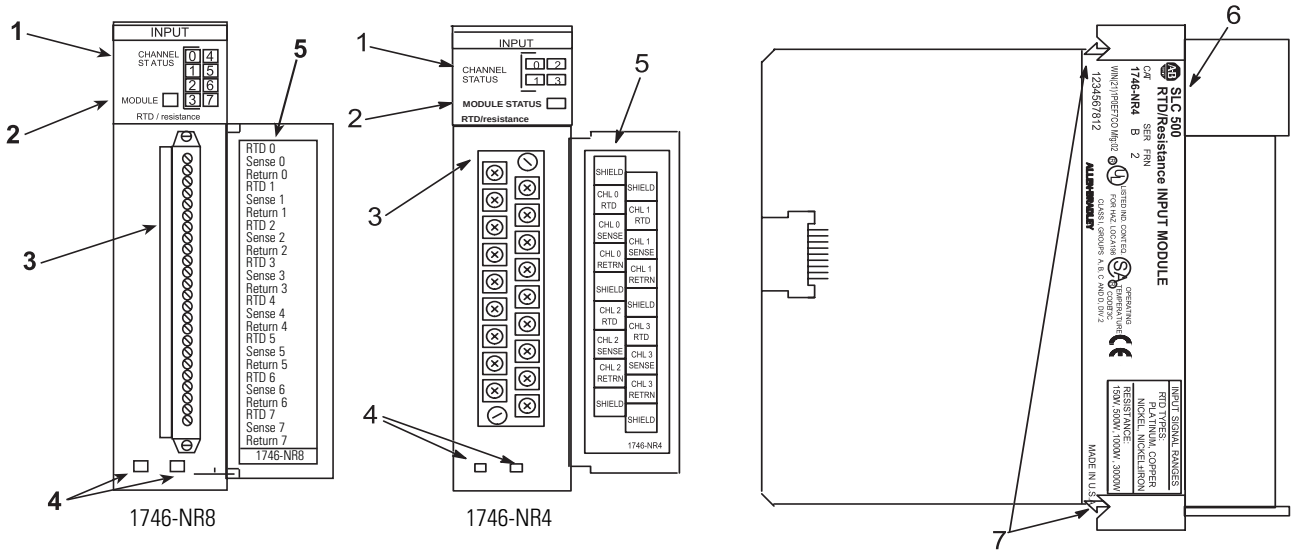
The modules provide high accuracy in a small package. Typical module accuracy is 0.05% of full scale for platinum RTDs. In addition, two current sources per channel are user-selectable to limit RTD self-heating and provide greater system temperature accuracy.

Hardware Overview

The modules fit into any single-slot of an SLC 500 modular system (except the processor slot), or an SLC 500 fixed system expansion chassis. The 1746-NR4 has four input channels. The 1746-NR8 has eight input channels. Inputs are multiplexed into an A/D converter. There are no output channels on the module.

The modules contain a removable terminal block providing connection for any mix of RTD sensors or resistance input devices. The modules interface with up to 12 RTD types such as platinum, nickel, copper, and nickel-iron, and with resistance devices such as potentiometers.

Module configuration is done via the user program. There are no DIP switches.



1746-NR8 1746-NR4

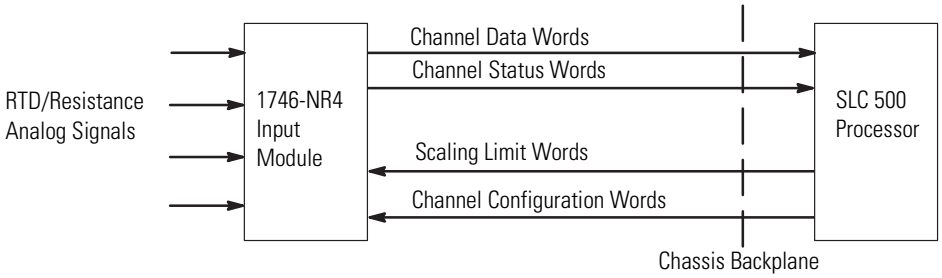
Table 1 Hardware Features

Feature		Function
1	Channel Status LED Indicators (Green)	Displays operating and fault status of each channel
2	Module Status LED (Green)	Displays module operating and fault status
3	Removable Terminal Block	Provides physical connection to input devices
4	Cable Tie Slots	Secures wiring from module
5	Door Label	Permits easy terminal identification
6	Side Label (Nameplate)	Provides module information
7	Self-Locking Tabs	Secures module in chassis slot

Module Operation

At module power-up, a series of internal diagnostic tests is performed. If any diagnostic test fails, the module enters the module error state. If all tests pass, the module initializes its hardware and software environment and turns on the module status LED. During power-up, the RTD module does not communicate with the processor.

After power-up checks are complete, the RTD module waits for valid channel configuration data from your SLC ladder logic program (channel status LEDs off). After configuration data is written to one or more channel configuration words and the respective channel enable bits are set by the user control program, the channel status LEDs go on and the module continuously converts the RTD or resistance input to a value within the range you selected for the enabled channels. The module is now operating in its normal state.



Each time a channel is read by the module, that data value is tested for an under-range, over-range, open-circuit or short-circuit condition. If such a condition is detected, an error bit is set in the channel status word and the appropriate channel LED blinks.

The SLC processor reads the converted RTD or resistance data from the module at the end of the program scan, or when commanded by the ladder program. The processor and RTD module determine that the backplane data transfer was made without error, and the data is used in your ladder program.

Calibration

The RTD modules are initially calibrated at the factory. The modules also have an autocalibration function. Autocalibration compensates for offset and gain drift of the analog circuitry caused by temperature change within the module. When a channel becomes enabled, the module configures the channel and performs the autocalibration on the channel. Each of the module's channels undergoes a calibration cycle at power-up, on channel configuration, or on your command via the ladder program.

A single-point calibration procedure can also be used to improve the accuracy of the RTD module and cable combination to ±0.2°C. No external, user-supplied device is required for autocalibration.

The 1746-NR8 module can also be configured to perform an autocalibration cycle every 5 minutes.

Compatibility with Controllers and RTD Sensors

The modules are fully compatible with all SLC 500 fixed and modular controllers. They are compatible with all RTDs that conform to the international and local standards shown in Table 2, “RTD Standards” .

Table 2 RTD Standards

RTD Type	α (3)	IEC (4)	DIN (5)	D100 (6)	SAMA (7)	JIS (old) (8)	JIS (new) (9)	Minco(10)
100Ω Platinum	0.00385	X	X				X	
200Ω Platinum	0.00385	X	X				X	
500Ω Platinum	0.00385	X	X				X	
1000Ω Platinum	0.00385	X	X				X	
100Ω Platinum	0.03916			X		X		
200Ω Platinum	0.03916			X		X		
500Ω Platinum	0.03916			X		X		
1000Ω Platinum	0.03916			X		X		
10Ω Copper (1)	0.00426				X			
120Ω Nickel(2)	0.00618		X					
120Ω Nickel	0.00672							X
604Ω Nickel Iron	0.00518							X

(1) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.
(2) Actual value at 0°C is 100Ω per DIN standard.
(3) a is the temperature coefficient of resistance, which is defined as the resistance change per ohm per°C.
(4) International Electrotechnical Commission Standard 751-1983.
(5) German Standard, DIN 43760-1980 and DIN 43760-1987.
(6) U.S. Standard D100
(7) Scientific Apparatus Makers Association Standard RC21-4-1966
(8) Japanese Industrial Standard JIS C1604-1981
(9) Japanese Standard JIS C1604-1989
(10) Minco Type NA (nickel) and Minco Type FA (nickel-iron)

Compatibility in a Fixed Expansion Chassis

The two-slot, SLC 500 fixed I/O expansion chassis supports only specific combinations of modules. The table below lists invalid combinations.

Table 3 Compatibility Requirements

The NR4 module cannot be used with these modules:		The NR4 and NR8 modules can be used with these modules and an external power supply:	The NR8 module cannot be used with these modules:	
OA16	NIO4I	NO4I	OA16	NI8
OAP12	FIO4I	NO4V	OAP12	NIO4I
OW16			OW16	FIO4I

Refer to the 1746-NR4 *SLC 500™ RTD/Resistance Input Module User’s Manual* (publication number 1746-6.7) or 1746-NR8 *SLC 500™ RTD/ Resistance Input Module User’s Manual* (publication number 1746-UM003A-EN-P) for complete compatibility information.

RTD/Resistance Compatibility and Specifications

The tables on pages 6 through 9 list the RTD types, the associated temperature ranges, and RTD specifications for the 1746-NR4 and 1746-NR8. The tables on page 10 list the resistance ranges for potentiometers and associated specifications.

Table 4 1746-NR4 RTD Range, Resolution, and Repeatability

RTD Input Type[1]		Temperature Range (0.5 mA Excitation)[4]	Temperature Range (2.0 mA Excitation)[4]	Resolution	Repeatability
Platinum (385)	100Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +850°C (-328°F to +1562°F)	0.1°C (0.2°F)	± 0.2°C (± 0.4°F)
	200Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +850°C (-328°F to +1562°F)	0.1°C (0.2°F)	± 0.2°C (± 0.4°F)
	500Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +850°C (-328°F to +1562°F)	0.1°C (0.2°F)	± 0.2°C (± 0.4°F)
	1000Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +240°C (-328°F to +464°F)	0.1°C (0.2°F)	± 0.2°C (± 0.4°F)
Platinum (3916)	100Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +630°C (-328°F to +1166°F)	0.1°C (0.2°F)	± 0.2°C (± 0.4°F)
	200Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +630°C (-328°F to +1166°F)	0.1°C (0.2°F)	± 0.2°C (± 0.4°F)
	500Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +630°C (-328°F to +1166°F)	0.1°C (0.2°F)	± 0.2°C (± 0.4°F)
	1000Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +230°C (-328°F to +446°F)	0.1°C (0.2°F)	± 0.2°C (± 0.4°F)
Copper (426)[2]	10Ω	Not allowed.[5]	-100°C to +260°C (-148°F to +500°F)	0.1°C (0.2°F)	± 0.2°C (± 0.4°F)
Nickel (618)[3]	120Ω	-100°C to +260°C (-148°F to +500°F)	-100°C to +260°C (-148°F to +500°F)	0.1°C (0.2°F)	± 0.1°C (± 0.2°F)
Nickel (672)	120Ω	-80°C to +260°C (-112°F to +500°F)	-80°C to +260°C (-112°F to +500°F)	0.1°C (0.2°F)	± 0.1°C (± 0.2°F)
Nickel/Iron (518)	604Ω	-100°C to +200°C (-148°F to +392°F)	-100°C to +200°C (-148°F to +392°F)	0.1°C (0.2°F)	± 0.1°C (± 0.2°F)

(1) The digits following the RTD type represent the temperature coefficient of resistance (α), which is defined as the resistance change per ohm per °C. For instance, *Platinum 385* refers to a platinum RTD with α = 0.00385 ohms/ohm-°C, or simply 0.00385/°C.

(2) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(3) Actual value at 0°C is 100Ω per DIN standard.

(4) The temperature range for the 1000Ω RTD is dependant on the excitation current.

(5) To maximize the relatively small RTD signal, only 2 mA excitation current is allowed.

Table 5 1746-NR8 RTD Range, Resolution, and Repeatability

RTD Input Type[1]		Temp. Range (0.25 mA Excitation)[4]	Temp. Range (1.0 mA Excitation)[4]	Resolution	Repeatability (28 Hz, 50/60 Hz)
Platinum (385)	100Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +850°C (-328°F to +1562°F)	0.1°C (0.1°F)	± 0.2°C (± 0.4°F)
	200Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +850°C (-328°F to +1562°F)	0.1°C (0.1°F)	± 0.2°C (± 0.4°F)
	500Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +390°C (-328°F to +698°F)	0.1°C (0.1°F)	± 0.2°C (± 0.4°F)
	1000Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +50°C (-328°F to +122°F)	0.1°C (0.1°F)	± 0.2°C (± 0.4°F)
Platinum (3916)	100Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +630°C (-328°F to +1166°F)	0.1°C (0.1°F)	± 0.2°C (± 0.4°F)
	200Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +630°C (-328°F to +1166°F)	0.1°C (0.1°F)	± 0.2°C (± 0.4°F)
	500Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +380°C (-328°F to +698°F)	0.1°C (0.1°F)	± 0.2°C (± 0.4°F)
	1000Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +50°C (-328°F to +122°F)	0.1°C (0.1°F)	± 0.2°C (± 0.4°F)
Copper (426) [2]	10Ω	-100°C to +260°C (-328°F to +500°F)	-100°C to +260°C (-328°F to +500°F)	0.1°C (0.1°F)	± 0.2°C (± 0.4°F)
Nickel (618) [3]	120Ω	-100°C to +260°C (-328°F to +500°F)	-100°C to +260°C (-328°F to +500°F)	0.1°C (0.1°F)	± 0.1°C (± 0.2°F)
Nickel (672)	120Ω	-80°C to +260°C (-328°F to +500°F)	-80°C to +260°C (-328°F to +500°F)	0.1°C (0.1°F)	± 0.1°C (± 0.2°F)
Nickel Iron (518)	604Ω	-200°C to +200°C (-328°F to +392°F)	-200°C to +180°C (-328°F to +338°F)	0.1°C (0.1°F)	± 0.1°C (± 0.2°F)

(1) The digits following the RTD type represent the temperature coefficient of resistance (α), which is defined as the resistance change per ohm per °C. For instance, Platinum 385 refers to a platinum RTD with α = 0.00385 ohms/ohm ·°C or simply 0.00385 /°C.

(2) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(3) Actual value at 0°C is 100Ω per DIN standard.

(4) The temperature range for the 1000Ω, 500Ω, and 604Ω RTD is dependent on the excitation current.

Table 6 1746-NR4 RTD Accuracy and Temperature Drift Specifications

RTD Type[1]		Accuracy[4] (0.5 mA Excitation)	Accuracy[4] (2.0 mA Excitation)	Temperature Drift[7] (0.5 mA Excitation)	Temperature Drift[7] (2.0 mA Excitation)
Platinum (385)	100Ω	±1.0°C[5] (±2.0°F)	±0.5°C (±.9°F)	±0.034°C/°C (±0.061°F/°F)	±0.014°C/°C (±0.025°F/°F)
	200Ω	±1.0°C[5] ± 2.0°F)	±0.5°C (±0.9°F)	±0.034°C/°C (±0.061°F/°F)	± 0.014°C/°C (± 0.025°F/°F)
	500Ω	±0.6°C (±1.1°F)	±0.5°C (±0.9°F)	±0.017°C/°C (±0.031°F/°F)	±0.014°C/°C (±0.025°F/°F)
	1000Ω	±0.6°C (±1.1°F)	±0.5°C (±0.9°F)	±0.017°C/°C (±0.031°F/°F)	±0.014°C/°C (±0.025°F/°F)
Platinum (3916)	100Ω	±1.0°C[5] (±2.0°F)	±0.4°C (±0.7°F)	±0.034°C/°C (±0.061°F/°F)	±0.011°C/°C (±0.020°F/°F)
	200Ω	±1.0°C[5] ±2.0°F)	±0.4°C (±0.7°F)	±0.034°C/°C (±0.061°F/°F)	±0.011°C/°C (±0.020°F/°F)
	500Ω	±0.5°C (±0.9°F)	±0.4°C (±0.7°F)	±0.014°C/°C (±0.025°F/°F)	±0.011°C/°C (±0.020°F/°F)
	1000Ω	±0.5°C (±0.9°F)	±0.4°C (±0.7°F)	±0.014°C/°C (±0.025°F/°F)	±0.011°C/°C (±0.020°F/°F)
Copper (426) [2]	10Ω	Not allowed[6].	±0.6°C (±1.1°F)	Not allowed.[6]	±0.017°C/°C (±0.031°F/°F)
Nickel (618) [3]	120Ω	±0.2°C (±0.4°F)	±0.2°C (±0.4°F)	±0.008°C/°C (±0.014°F/°F)	±0.008°C/°C (±0.014°F/°F)
Nickel (672)	120Ω	±0.2°C (±0.4°F)	±0.2°C (±0.4°F)	±0.008°C/°C (±0.014°F/°F)	±0.008°C/°C (±0.014°F/°F)
Nickel Iron (518)	604Ω	±0.3°C (±0.5°F)	±0.3°C (±0.5°F)	±0.010°C/°C (±0.018°F/°F)	±0.010°C/°C (±0.018°F/°F)

(1) The digits following the RTD type represent the temperature coefficient of resistance (α), which is defined as the resistance change per ohm per °C. For instance, *Platinum 385* refers to a platinum RTD with α = 0.00385 ohms/ohm-°C, or simply 0.00385/°C.

(2) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(3) Actual value at 0°C is 100Ω per DIN standard.

(4) The accuracy values assume that the module was calibrated within the specified temperature range of 0°C to +60°C (+32°F to +140°F)

(5) Module accuracy, using 100Ω or 200Ω platinum RTDs with 0.5 mA excitation current, depends on the following criteria:
- Module accuracy is M0.6°C after you apply power to the module or perform an autocalibration at 25°C ambient with the module operation temperature at 25°C.
- Module accuracy is ±(0.6°C + DT x 0.034°C/°C) after you apply power to the module or perform an autocalibration at 25°C ambient with the module operating temperature between 0° to 60°C.
- where DT is the temperature difference between the actual operating temperature of the module and 25°C and 0.034°C/°C is the temperature drift shown in the table above for 100a or 200a platinum RTDs.
- Module accuracy is ±1.0°C after you apply power to the module or perform an autocalibration at 60°C ambient with module operating temperature at 60°C.

(6) To maximize the relatively small RTD signal, only 2 mA excitation current is allowed.

(7) Temperature drift specifications apply to a module that has not been calibrated.

Table 7 1746-NR8 RTD Accuracy and Temperature Drift Specifications

Input Type[1]		Accuracy[4] (0.25 mA Excitation)	Accuracy[4] (1.0 mA Excitation)	Temperature Drift[5] (0.25 mA Excitation)	Temperature Drift[5] (1.0 mA Excitation)
Platinum (385)	100Ω	±0.5°C (±0.9°F)	±0.7°C (±1.3°F)	±0.012°C/°C (±0.012°F/°F)	±0.020°C/°C (±0.020°F/°F)
	200Ω	±0.6°C (±1.1°F)	±0.7°C (±1.3°F)	±0.015°C/°C (± 0.015°F/°F)	±0.020°C/°C (±0.020°F/°F)
	500Ω	±0.7°C (±1.3°F)	±0.5°C (± 0.9°F)	±0.020°C/°C (±0.020°F/°F)	±0.012°C/°C (±0.012°F/°F)
	1000Ω	±1.2°C (±2.2°F)	±0.4°C (±0.7°F)	±0.035°C/°C (±0.035°F/°F)	±0.010°C/°C (±0.010°F/°F)
Platinum (3916)	10 Ω	±0.4°C (±0.7°F)	±0.6°C (±1.1°F)	±0.010°C/°C (± 0.010°F/°F)	±0.015°C/°C (±0.015°F/°F)
	200Ω	±0.5°C (±0.9°F)	±0.6°C (±1.1°F)	±0.011°C/°C (±0.011°F/°F)	±0.015°C/°C (±0.015°F/°F)
	500Ω	±0.6°C (±1.1°F)	±0.4°C (±0.7°F)	±0.015°C/°C (± 0.015°F/°F)	±0.012°C/°C (±0.012°F/°F)
	1000Ω	±0.9°C (±1.6°F)	±0.3°C (±0.6°F)	±0.026°C/°C (±0.026°F/°F)	±0.010°C/°C (±0.010°F/°F)
Copper (426)[2]	10Ω	±0.5°C (±0.9°F)	±0.8°C (±1.4°F)	±0.008°C/°C (±0.008°F/F)	±0.008°C/°C (±0.008°F/°F)
Nickel (618)[3]	120Ω	± 0.2°C (±0.4°F)	±0.2°C (±0.4°F)	±0.003°C/°C (±0.003°F/°F)	±0.005°C/°C (±0.005°F/°F)
Nickel (672)	120Ω	±0.2°C (±0.4°F)	±0.2°C (±0.4°F)	±0.003°C/°C (±0.003°F/°F)	±0.005°C/°C (±0.005°F/°F)
Nickel Iron (518)	604Ω	±0.3°C (±0.5°F)	±0.3°C (± 0.5°F)	±0.008°C/°C (±0.008°F/°F)	±0.008°C/°C (±0.008°F/°F)

(1) The digits following the RTD type represent the temperature coefficient of resistance (α), which is defined as the resistance change per ohm per °C. For instance, *Platinum 385* refers to a platinum RTD with α = 0.00385 ohms/ohm-°C, or simply 0.00385/°C.

(2) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(3) Actual value at 0°C is 100Ω per DIN standard.

(4) The accuracy value assumes that the module was calibrated with in the specified temperature range of 0°C to +60°C (+32°F to +140°F).

(5) Temperature drift specifications apply to a module that has not been calibrated.

Table 8 1746-NR4 Resistance Input Specifications

Resistance	Resistance Range (0.5 mA Excitation)	Resistance Range (2.0 mA Excitation)	Accuracy(1)	Temperature Drift	Resolution	Repeatability
150Ω	0 Ω to 150 Ω	0 Ω to 150 Ω	±0.2Ω at 0.5 mA ±0.15Ω at 2.0 mA	±0.006Ω/°C at 0.5 mA ±0.004Ω/°C at 2.0 mA	0.01Ω	±0.04Ω
500Ω	0 Ω to 500 Ω	0 Ω to 500 Ω	±0.5Ω	±0.014 Ω/°C (±0.025 Ω/°F)	0.1Ω	±0.2Ω
1000Ω	0 Ω to 1000 Ω	0 Ω to 1000 Ω	±1.0Ω	±0.029 Ω/°C (±0.052 Ω/°F)	0.1Ω	±0.2Ω
3000Ω	0 Ω to 3000 Ω	0 Ω to 1900 Ω	±1.5Ω	±0.043 Ω/°C (±0.077 Ω/°F)	0.1Ω	±0.2Ω

(1) The accuracy values assume that the module was calibrated within the specified temperature range of 0°C to 60°C (32°F to 140°F).

Table 9 1746-NR8 Resistance Input Specifications

Resistance	Resistance Range (0.25 mA Excitation)	Resistance Range (1.0 mA Excitation)	Accuracy(1)	Temperature Drift	Resolution	Repeatability
150Ω	0Ω to 150Ω	0Ω to 150Ω	0.2Ω at 0.25 mA 0.15Ω at 1.0 mA	±0.004Ω/°C (±0.002Ω/°F) (2)	0.01Ω	± 0.04Ω
500Ω	0Ω to 500Ω	0Ω to 500Ω	± 0.5Ω	± 0.012Ω/°C (± 0.007Ω/°F)	0.1Ω	± 0.2Ω
1000Ω	0Ω to 1000Ω	0Ω to 1000Ω	± 1.0Ω	± 0.025Ω/°C (± 0.014Ω/°F)	0.1Ω	± 0.2Ω
3000Ω	0Ω to 3000Ω	0Ω to 1200Ω	± 1.5Ω	± 0.040Ω/°C (± 0.023Ω/°F)	0.1Ω	± 0.2Ω

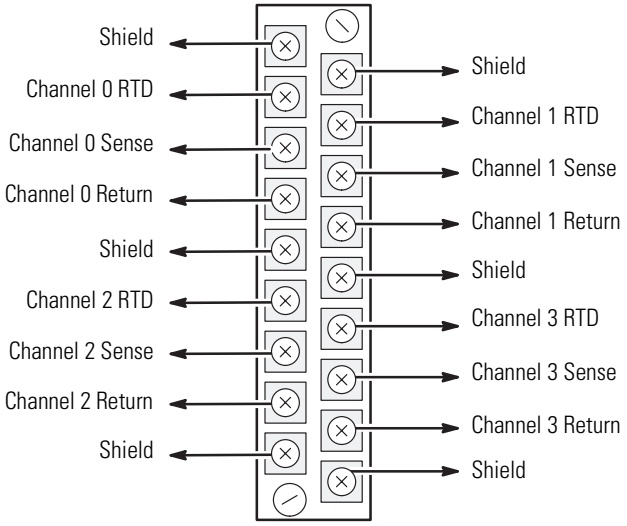
(1) The accuracy values assume that the module was calibrated within the specified temperature range of 0°C to 60°C (32°F to 140°F).

(2) The temperature drift for 150Ω is dependent on the excitation current: 0.006Ω/°C at 0.25 mA and 0.004Ω at 1.0 mA

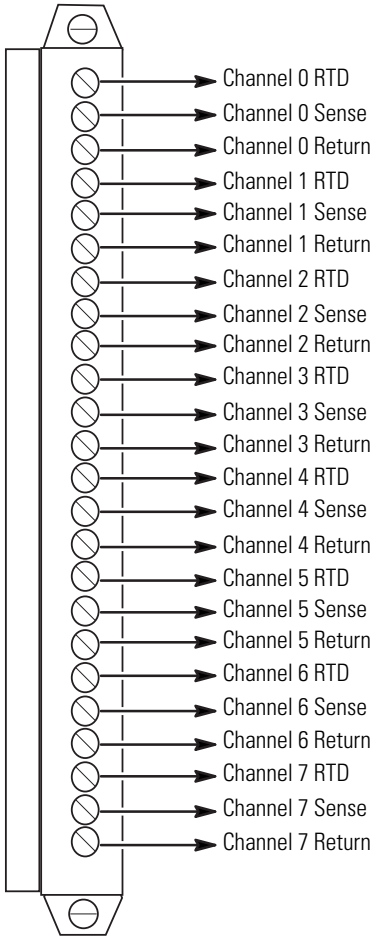
Module Wiring

The RTD input modules contain removable terminal blocks, as shown below.

1746-NR4



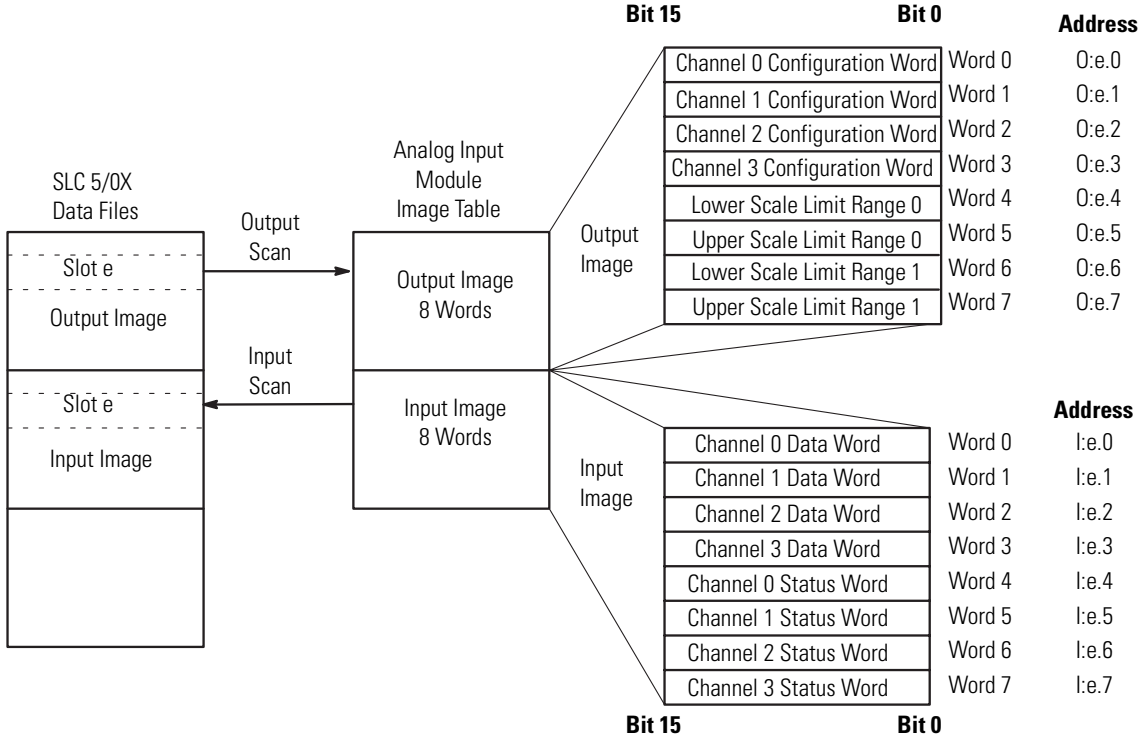
1746-NR8



Module Addressing

The 1746-NR4 uses eight input words and eight output words, as shown in the memory map on page 12.

Figure 10 1746-NR4 Memory Map



The 1746-NR8 has two operating modes, which determine how many input and output words the module uses. In Class 1, the module uses 8 input and 8 output words. In Class 3, the module uses 16 input and 24 output words.

Figure 11 1746-NR8 Class 1 Memory Map

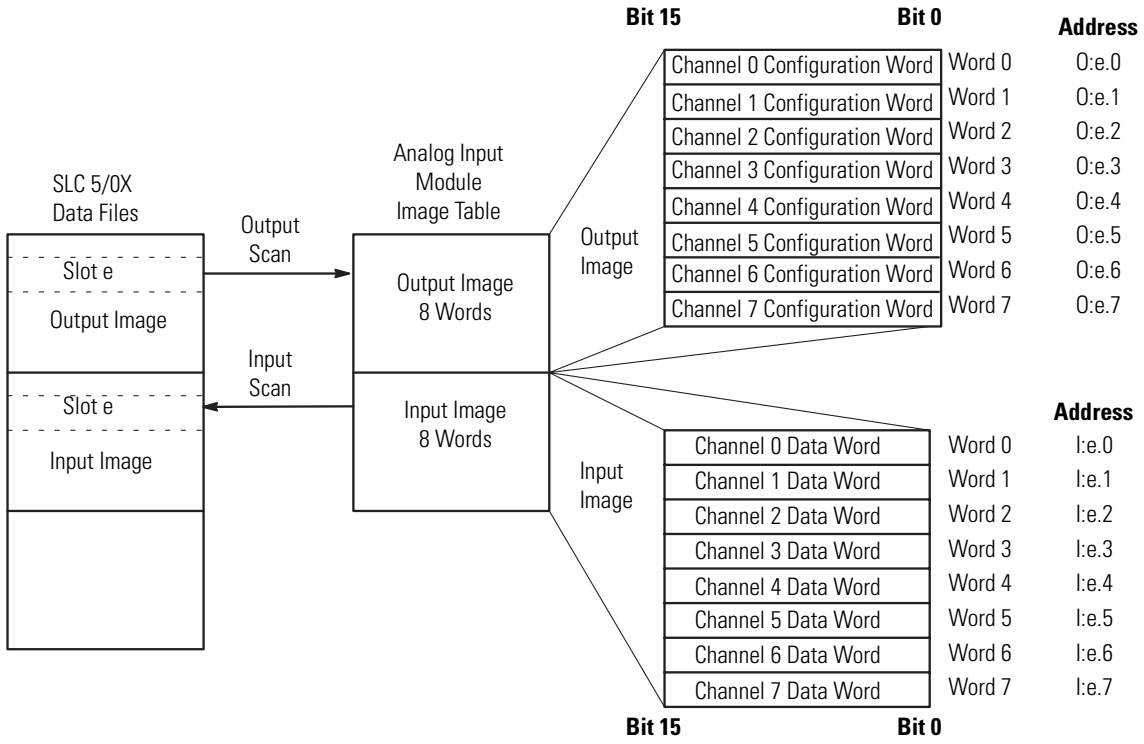
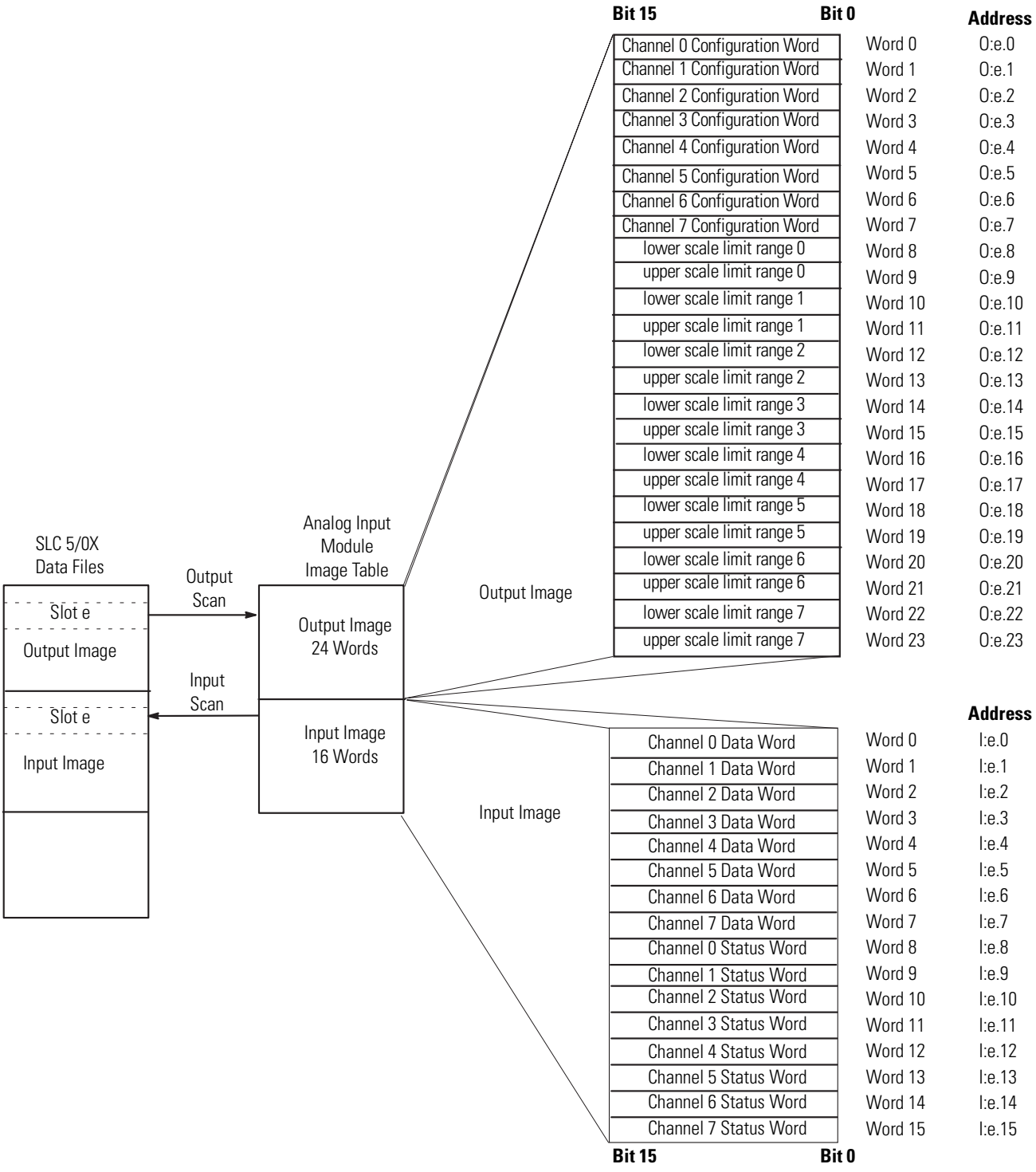


Figure 12 1746-NR8 Class 3 Memory Map



Channel Data and Status (Input Image)

Data words hold the input data that represent the temperature value of RTD analog inputs or the resistance value of resistive inputs for each channel. The data word is valid only when the channel is enabled and there are no channel errors.

Status words contain the status of each channel. The status bits for a particular channel reflect the configuration settings that you have entered into the output image configuration word for that channel, as well as providing information about the channel's operational state. To receive valid status information the channel must be enabled, and the channel must have processed any configuration changes that may have been made to the configuration word.

Channel Configuration (Output Image)

Once the module has been installed, each channel on the module can be configured to establish the way the channel will operate. You configure the channel by entering bit values into the configuration word using your programming software. Channels 0-3 on the 1746-NR4 module are configured by entering bit values into output words 0-3, respectively. Similarly, channels 0-7 on the 1746-NR8 module are configured by entering bit values into output words 0-7, respectively.

Output words 4-7 on the 1746-NR4 are used for scaling purposes. Output words 8 through 23 (Class 3 only) on the 1746-NR8 are also used for scaling.

You can configure the following parameters:

Table 13 Configurable Parameters

Parameter	1746-NR4	1746-NR8
RTD Type(1)	100Ω, 200Ω, 500Ω,1000Ω Platinum (385) 10Ω Copper (426)(2) 120Ω Nickel (672)	100Ω, 200Ω, 500Ω,1000Ω Platinum (3916) 120Ω Nickel (618)(3) 604Ω Nickel/Iron (518)
Resistance Device Type	150, 500, 1000, or 3000 ohm	
Data Format	1.0 degree, 0.1 degrees, 1 ohm, 0.1 ohms, 0.01 ohms (for 150 ohm range only), proportional counts, or scaled-for-PID	
Open /Short Circuit	Zero, upscale, or downscale	
Temperature Units	°C or °F	
Filter Frequency	10 Hz, 50 Hz, 60 Hz, or 250 Hz	28 Hz, 50/60 Hz, 800 Hz, or 6400 Hz
RTD Excitation Current	0.5 mA or 2.0 mA	0.25 mA or 1.0 mA
Scaling	Scaled-for-PID: 0 to 16383 Proportional Counts: -32768 to +32767 User-defined: 2 ranges (lower/upper)	Scaled-for-PID: 0 to 16383 Proportional Counts: -32768 to +32767 User-defined: 2 ranges (lower/upper)
Periodic Calibration	Not configurable	Enable or Disable
Lead Resistance Measurement	Not configurable	Disable, periodic, or always

(1) The digits in parenthesis following the RTD type represent the temperature coefficient of resistance (α) that is defined as the resistance change per ohm per °C. For instance, Platinum 385 refers to a platinum RTD with α = 0.00385 ohms/ohm-°C, or simply 0.00385.°C.

(2) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(3) Actual value at 0°C is 100Ω per DIN standard.

1746-NR8 Class 1 or Class 3 Operation

The 1746-NR8 module can be configured for Class 1 or Class 3 operation. The table below explains the difference between the classes.

NOTE The 1746-NR4 module operates only in Class 1. See Figure 10 on page 12 for the 1746-NR4 memory map.

Table 14 Class 1 vs. Class 3 Operation

Configuration	Class 1	Class 3
Compatible SLC Processors	SLC 500 fixed, SLC 5/01 and higher	SLC 5/02 and higher
Compatible Chassis	local chassis or remote chassis with 1747-ASB Adapter(1)	local chassis or remote chassis with a 1747-ACN(R)15 ControlNet Adapter
1746-NR8 Input Image	8 channel data words	8 channel data words 8 channel status words
1747-NR8 Output Image	8 channel configuration words	8 channel configuration words 16 words for user-set scaling
Default	Class 1 is the default on power-up	Class 3 is programmable by the user

(1) Requires use of BlockTransfer in a remote configuration.

Data Format

The format of the data that the RTD module sends back to the SLC processor depends on how the bits are set in the configuration word. Specific bit fields represent various channel characteristics. Each of these characteristics can be modified from its power-up default setting at any time while the module is operating.

Specific bit settings are discussed in the *1746-NR4 SLC 500™ RTD/Resistance Input Module User's Manual* (publication number 1746-6.7) and *1746-NR8 SLC 500™ RTD/Resistance Input Module User's Manual* (publication number 1746-UM003A-EN-P).

The tables on pages 16 through 20 define the data formats and the resolutions that can be represented for each input type.

In these tables:

- **Engineering Units** provide the input value directly in °C, °F, or ohms.
- **Scaled-for-PID** provides a data format directly compatible with the SLC 5/02, SLC 5/03, SLC 5/04, and SLC 5/05 PID algorithm. It also requires manual conversion to engineering units.
- **Proportional Counts** provide the greatest possible resolution but require manual conversion to engineering units in your control program.

Table 15 1746-NR4 Data Formats for RTD Temperature Ranges

RTD Input Type	Data Format Using 0.5 and 2.0 mA Excitation Current					
	Engineering Units x 1		Engineering Units x 10		Scaled-for-PID	Proportional Counts (Default)
	0.1°C	0.1°F	1.0°C	1.0°F		
100 Ω Platinum (385)	-2000 to +8500	-3280 to +15620	-200 to +850	-328 to +1562	0 to 16383	-32768 to 32767
200 Ω Platinum (385)	-2000 to +8500	-3280 to +15620	-200 to +850	-328 to +1562	0 to 16383	-32768 to 32767
500 Ω Platinum (385)	-2000 to +8500	-3280 to +15620	-200 to +850	-328 to +1562	0 to 16383	-32768 to 32767
100 Ω Platinum (3916)	-2000 to +6300	-3280 to +11660	-200 to +630	-328 to +1166	0 to 16383	-32768 to 32767
200 Ω Platinum (3916)	-2000 to +6300	-3280 to +11660	-200 to +630	-328 to +1166	0 to 16383	-32768 to 32767
500 Ω Platinum (3916)	-2000 to +6300	-3280 to +11660	-200 to +630	-328 to +1166	0 to 16383	-32768 to 32767
120 Ω Nickel (672)	-800 to +2600	-1120 to +5000	-80 to +260	-112 to +500	0 to 16383	-32768 to 32767
120 Ω Nickel (618)(1)	-1000 to +2600	-1480 to +5000	-100 to +260	-148 to +500	0 to 16383	-32768 to 32767
604 Ω Nickel/Iron (518)	-1000 to +2000	-1480 to +3920	-100 to +200	-148 to +392	0 to 16383	-32768 to 32767
10 Ω Copper (426)(2) at 2.0 mA only(3)	-1000 to +2600	-1480 to +5000	-100 to +260	-148 to +500	0 to 16383	-32768 to 32767

(1) Actual value at 0°C is 100Ω per DIN standard.

(2) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(3) 0.5 excitation current is not allowed.

Table 16 1746-NR8 Data Formats for RTD Temperature Ranges

RTD Input Type	Data Format Using 0.25 and 1.0 mA Excitation Current					
	Engineering Units x 1		Engineering Units x 10		Scaled-for-PID	Proportional Counts (Default)
	0.1°C	0.1°F	1.0°C	1.0°F		
100Ω Platinum (385)	-2000 to +8500	-3280 to +15620	-200 to +850	-328 to +1562	0 to 16383	-32768 to 32767
200Ω Platinum (385)	-2000 to +6300	-3280 to + 6300	-200 to +630	-328 to +630	0 to 16383	-32768 to 32767
100Ω Platinum (3916)	-2000 to +6300	-3280 to +6300	-200 to +630	-328 to +630	0 to 16383	-32768 to 32767
200Ω Platinum (3916)	-2000 to +6300	-3280 to +6300	-200 to +630	-328 to +630	0 to 16383	-32768 to 32767
120Ω Nickel (672)	-800 to +2600	-3280 to +5000	-80 to +260	-328 to +500	0 to 16383	-32768 to 32767
120Ω Nickel (618)(1)	-1000 to +2600	-3280 to +5000	-100 to +260	-328 to +500	0 to 16383	-32768 to 32767
604 Ω Nickel/Iron (518) at 0.25 mA only	-2000 to +2000	-3280 to +3920	-200 to +200	-328 to +392	0 to 16383	-32768 to 32767
604 Ω Nickel/Iron (518) at 1.0 mA only	-2000 to +1800	-3280 to +3380	-200 to +180	-328 to +338	0 to 16383	-32768 to 32767
10Ω Copper (426)(2)	-1000 to +2600	-3280 to +5000	-100 to +260	-328 to +500	0 to 16383	-32768 to 32767

(1) Actual value at 0°C is 100Ω per DIN standard.

(2) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

Table 17 Data Format for 1000 Ω Platinum RTD Input Type

Module	RTD Input Type	Excitation Current	Data Format					
			Engineering Units x 1		Engineering Units x 10		Scaled-for-PID	Proportional Counts (Default)
			0.1°C	0.1°F	1.0°C	1.0°F		
1746-NR4	Platinum (385)	0.5 mA	-2000 to +8500	-3280 to +15620	-200 to +850	-328 to +1562	0 to 16383	-32768 to 32767
		2.0 mA	-2000 to +2400	-3280 to +4640	-200 to +240	-328 to +464	0 to 16383	-32768 to 32767
	Platinum (3916)	0.5 mA	-2000 to +6300	-3280 to +11660	-200 to +630	-328 to +1166	0 to 16383	-32768 to 32767
		2.0 mA	-2000 to +2300	-3280 to +44600	-200 to +230	-328 to +446	0 to 16383	-32768 to 32767
1746-NR8	Platinum (385)	0.25 mA	-2000 to +8500	-3280 to +15620	-200 to +850	-328 to +1562	0 to 16383	-32768 to 32767
		1.0 mA	-2000 to +500	-3280 to +1220	-200 to +50	-328 to +122	0 to 16383	-32768 to 32767
	Platinum (3916)	0.25 mA	-2000 to +6300	-3280 to +11660	-200 to +630	-328 to +1166	0 to 16383	-32768 to 32767
		1.0 mA	-2000 to +500	-3280 to +1220	-200 to +50	-328 to +122	0 to 16383	-32768 to 32767

Table 18 Data Format for 500 Ω Platinum RTD Input Type

Module	RTD Input Type	Excitation Current	Engineering Units x 1		Engineering Units x 10		Scaled-for-PID	Proportional Counts (Default)
			0.1°C	0.1°F	1.0°C	1.0°F		
1746-NR4	Platinum (385)	0.5 mA	-2000 to +8500	-3280 to +15620	-200 to +850	-328 to +1562	0 to 16383	-32768 to 32767
		2.0 mA						
	Platinum (3916)	0.5 mA	-2000 to +6300	-3280 to +11660	-200 to +630	-328 to +1166	0 to 16383	-32768 to 32767
		2.0 mA						
1746-NR8	Platinum (385)	0.25 mA	-2000 to +8500	-3280 to +15620	-200 to +850	-328 to +1562	0 to 16383	-32768 to 32767
		1.0 mA	-2000 to +3900	-3280 to +6980	-200 to +390	-328 to +698	0 to 16383	-32768 to 32767
	Platinum (3916)	0.25 mA	-2000 to +6300	-3280 to +11660	-200 to +630	-328 to +1166	0 to 16383	-32768 to 32767
		1.0 mA	-2000 to +3800	-3280 to +6980	-200 to +380	-328 to +698	0 to 16383	-32768 to 32767

Table 19 Data Format for Resistance Inputs

Module	Resistance Input Type		Data Format			
			Engineering Units x 1	Engineering Units x 10	Scaled-for-PID	Proportional Counts (Default)
			0.01 Ohms(1)	0.1 Ohms(1)		
Both	150Ω		0 to 15000	0 to 1500	0 to 16383	-32768 to 32767
	500Ω		0 to 5000	0 to 500	0 to 16383	-32768 to 32767
	1000Ω		0 to 10000	0 to 1000	0 to 16383	-32768 to 32767
1746-NR4	3000Ω	0.5 mA excitation	0 to 30000	0 to 3000	0 to 16383	-32768 to 32767
		2.0 mA excitation	0 to 19000	0 to 1900	0 to 16383	-32768 to 32767
1746-NR8	3000Ω	0.25 mA excitation	0 to 30000	0 to 3000	0 to 16383	-32768 to 32767
		1.0 mA excitation	0 to 12000	0 to 1200	0 to 16383	-32768 to 32767

(1) When ohms are selected, the temperature-units selection (bit 8) is ignored. Analog input data is the same for either °C or °F selection.

Table 20 1746-NR4 Channel Data Word Resolution for RTDs

RTD Input Type	Data Format (Bits 4 and 5)(3)							
	Engineering Units x 1		Engineering Units x 10		Scaled-for-PID		Proportional Counts (Default)	
	° C/step	° F/step	° C/step	° F/step	° C/step	° F/step	° C/step	° F/step
100 Ω Platinum 385	0.1	0.1	1.0	1.0	0.0641	0.1154	0.0160	0.0288
200 Ω Platinum 385	0.1	0.1	1.0	1.0	0.0641	0.1154	0.0160	0.0288
500 Ω Platinum 385	0.1	0.1	1.0	1.0	0.0641	0.1154	0.0160	0.0288
1000 Ω Platinum 385	0.1	0.1	1.0	1.0	0.0641	0.1154	0.0160	0.0288
100 Ω Platinum 3916	0.1	0.1	1.0	1.0	0.0507	0.0912	0.012 7	0.0228
200 Ω Platinum 3916	0.1	0.1	1.0	1.0	0.0507	0.0912	0.0127	0.0228
500 Ω Platinum 3916	0.1	0.1	1.0	1.0	0.0507	0.0912	0.0127	0.0228
1000 Ω Platinum 3916	0.1	0.1	1.0	1.0	0.0507	0.0912	0.0127	0.0228

Table 20 1746-NR4 Channel Data Word Resolution for RTDs

10 Ω Copper 426[1]	0.1	0.1	1.0	1.0	0.0220	0.0396	0.0051	0.0099
120 Ω Nickel 618[2]	0.1	0.1	1.0	1.0	0.0220	0.0396	0.0051	0.0099
120 Ω Nickel 672	0.1	0.1	1.0	1.0	0.0208	0.0374	0.0052	0.0093
604 Ω Nickel/Iron 518	0.1	0.1	1.0	1.0	0.0183	0.0330	0.0046	0.0082

(1) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(2) Actual value at 0°C is 100Ω standard.

(3) When ohms are selected, the temperature-units selection (bit 8) is ignored. Analog input data is the same for either °C or °F selection.

Table 21 1746-NR8 Channel Data Word Resolution for RTDs

RTD Input Type		**Data Format (Bits 4 and 5)[3]**							
		Engineering Units x 1		**Engineering Units x 10**		**Scaled-for-PID**		**Proportional Counts (Default)**	
		° C/step	**° F/step**	**° C/step**	**° F/step**	**° C/step**	**° F/step**	**° C/step**	**° F/step**
100 Ω Platinum 385		0.1	0.1	1.0	1.0	0.0641	0.1154	0.0160	0.0288
200 Ω Platinum 385		0.1	0.1	1.0	1.0	0.0641	0.1154	0.0160	0.0288
500 Ω Platinum 385	0.25 mA excitation	0.1	0.1	1.0	1.0	0.0641	0.1154	0.0160	0.0288
	1.0 mA excitation	0.1	0.1	1.0	1.0	0.0360	0.0648	0.0090	0.0162
1000 Ω Platinum 385	0.25 mA excitation	0.1	0.1	1.0	1.0	0.0641	0.1154	0.0160	0.0288
	1.0 mA excitation	0.1	0.1	1.0	1.0	0.0153	0.10275	0.0038	0.0069
100 Ω Platinum 3916		0.1	0.1	1.0	1.0	0.0507	0.0912	0.0127	0.0228
200 Ω Platinum 3916		0.1	0.1	1.0	1.0	0.0507	0.0912	0.0127	0.0228
500 Ω Platinum 3916	0.25 mA excitation	0.1	0.1	1.0	1.0	0.0507	0.0912	0.0127	0.0228
	1.0 mA excitation	0.1	0.1	1.0	1.0	0.0354	0.0637	0.0089	0.0159
1000 Ω Platinum 3916	0.25 mA excitation	0.1	0.1	1.0	1.0	0.0507	0.0912	0.0127	0.0228
	1.0 mA excitation	0.1	0.1	1.0	1.0	0.0153	0.0275	0.0038	0.0104
10 Ω Copper 426[1]		0.1	0.1	1.0	1.0	0.0220	0.0396	0.0051	0.0099
120 Ω Nickel 618[2]		0.1	0.1	1.0	1.0	0.0220	0.0396	0.0051	0.0099
120 Ω Nickel 672		0.1	0.1	1.0	1.0	0.0208	0.0374	0.0052	0.0093
604 Ω Nickel/Iron 518	0.25 mA excitation	0.1	0.1	1.0	1.0	0.0183	0.0330	0.0046	0.0082
	1.0 mA excitation	0.1	0.1	1.0	1.0	0.0232	0.0417	0.0058	0.0104

(1) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(2) Actual value at 0°C is 100Ω standard.

(3) When ohms are selected, the temperature-units selection (bit 8) is ignored. Analog input data is the same for either °C or °F selection.

Table 22 Channel Data Word Resolution for Resistance Inputs

Resistance Input Type	Data Format (Bits 4 and 5)			
	Engineering Units x 1	Engineering Units x 10	Scaled-for-PID	Proportional Counts (Default)
	Ohms/step	Ohms/step	Ohms/step	Ohms/step
150Ω	0.01	0.1	0.0092	0.0023
500Ω	0.1	1	0.0305	0.0076
1000Ω	0.1	1	0.0610	0.0153
3000Ω	0.1	1	0.1831	0.0458

Module Diagnostics

The RTD module performs operations at two levels:

- module-level operations
- channel-level operations

Module-level operations include functions such as power-up configuration and communication with the SLC processor.

Channel-level operations describe channel-related functions, such as data conversion and out-of-range or open-circuit or short-circuit (RTDs only) detection.

Internal diagnostics are performed at both levels of operation and any error conditions detected are immediately indicated by the module's LEDs and status to the SLC processor.

Power-Up Diagnostics

At module power-up, a series of internal diagnostic tests is performed. If any diagnostic test fails, the module enters the module error state. If all tests pass, the module initializes its hardware and software environment and turns on the module status LED. During power-up, the RTD module does not communicate with the processor.

Channel Diagnostics

When a channel is enabled (bit 11 = 1), a diagnostic check is performed to see that the channel is properly configured. In addition, the channel is tested for out-of-range, open-circuit, and short-circuit faults on every scan.

A failure of any channel diagnostic test causes the faulted channel status LED to blink. All channel faults are indicated in bits 13 through 15 of the channel's status word. Channel faults are self-clearing when the fault conditions are corrected, and the channel LED will stop blinking and resume steady illumination when the fault conditions are corrected.

Specifications

	1746-NR4	1746-NR8
Backplane Current Consumption	50 mA at 5V dc 50 mA at 24V dc	100 mA at 5V dc 55 mA at 24V dc
Backplane Power Consumption	1.5W maximum (0.3 W at 5V dc, 1.2 W at 24V dc)	1.82W maximum (0.5W at 5V dc, 1.32W at 24V dc)
External Power Supply Requirements	None	
Number of Channels	4 (backplane isolated)	8 (backplane isolated)
I/O Chassis Location	Any I/O module slot except slot 0	
A/D Conversion Method	Sigma-Delta Modulation	
Input Filtering	Low pass digital filter with programmable notch (filter) frequencies	
Common Mode Rejection (between inputs and chassis ground)	> 150 dB at 50 Hz (10 Hz and 50 Hz filter frequencies) > 150 dB at 60 Hz (10 Hz and 60 Hz filter frequencies)	> 120 dB at 50 Hz (28 Hz and 50 Hz filter frequencies) > 120 dB at 60 Hz (28 Hz and 60 Hz filter frequencies)
Normal Mode Rejection (between [+] input and [-] input)	Greater than 100 dB at 50 Hz (10 Hz, 50 Hz filter frequencies) Greater than 100 dB at 60 Hz (10 Hz, 60 Hz filter frequencies)	65 dB at 50/60 Hz (with 50/60 Hz filter) 110 dB at 50 Hz (with 28 Hz filter) 95 dB at 60 Hz (with 28 Hz filter)
Maximum common mode voltage	± 1 volt	
Maximum allowed permanent overload(1)	Volts: ± 5V dc Current: ± 5mA	
Input Filter Cut-Off Frequencies	2.62 Hz at 10 Hz filter frequency 13.1 Hz at 50 Hz filter frequency 15.72 Hz at 60 Hz filter frequency 65.5 Hz at 250 Hz filter frequency	7.80 Hz at 28 Hz filter frequency 13.65 Hz at 50/60 Hz filter frequency 209.6 Hz at 800 Hz filter frequency 1676 Hz at 6400 Hz filter frequency
Calibration	Module autocalibrates when power is applied, a channel is enabled or when a change is made to its input type, filter frequency, or excitation current.	Set module calibration disable to zero to enable module to autocalibrate when power is applied, a channel is enabled, or when a change is made to the input type, filter frequency, or excitation current.
Isolation (optical)	500V dc continuous between inputs and chassis ground, and between inputs and backplane	707V dc for 1 minute
Isolation Between Inputs	None	±5V dc

(1) Do not apply a voltage or current to the module.

Table 23 Physical Specifications

	1746-NR4	1746-NR8
LED Indicators	green status indicators, one for each channel and one for module status	
Module ID Code	3513	Class 1: 3508 Class 3: 12708
Maximum Termination Wire Size	Two 14 AWG wire per terminal	One 14 AWG wire per terminal
Maximum Cable Impedance	25 ohms maximum impedance for 3-wire RTD configuration (see Cable Specifications)	
Removable Terminal Block	1746-RT25G	1746-RT35

Table 24 Environmental Specifications

Operating Temperature	0°C to +60°C (+32°F to+140°F)
Storage Temperature	–40°C to +85°C (–104°F to +185°F)
Relative Humidity	5% to 95% (without condensation)
Hazardous Environment Classification	Class I, Division 2 Hazardous Environment
Agency Certification (when product or packaging is marked)	• UL and CSA Class I Division 2 Groups A,B,C,D certified • CE compliant for all applicable directives

Table 25 Cable Specifications

Description	Belden #9501	Belden #9533	Belden #83503
When used?	For 2-wire RTDs and potentiometers.	For 3-wire RTDs and potentiometers. Short runs less than 100 feet and normal humidity levels.	For 3-wire RTDs and potentiometers. Long runs greater than 100 feet or high humidity levels.
Conductors	2, #24 AWG tinned copper (7× 32)	3, #24 AWG tinned copper (7× 32)	3, #24 AWG tinned copper (7× 32)
Shield	Beldfoil aluminum polyester shield with copper drain wire.	Beldfoil aluminum polyester shield with copper drain wire.	Beldfoil aluminum polyester shield with tinned braid shield.
Insulation	PVC	S-R PVC	Teflon
Jacket	Chrome PVC	Chrome PVC	Red teflon
Agency Approvals	NEC Type CM	NEC Type CM	NEC Art-800, Type CMP
Temperature Rating	+80°C	+80°C	+200°C

Table 26 Input Specifications

	1746-NR4	1746-NR8
RTD Type: (Temperature Range Independent of Excitation Current)	100Ω Platinum (385) -200°C to +850°C (-328°F to +1562°F) 200Ω Platinum (385) -200°C to +850°C (-328°F to +1562°F) 500Ω Platinum (385) -200°C to +850°C (-328°F to +1562°F) 100Ω Platinum (3916) -200°C to +630°C (-328°F to+1166°F) 200Ω Platinum (3916) -200°C to +630°C (-328°F to+1166°F) 500Ω Platinum (3916) -200°C to +630°C (-328°F to+1166°F) 120Ω Nickel (618)[2] -100°C to +260°C (-148°F to +500°F) 120Ω Nickel (672) -80°C to +260°C (-112°F to +500°F) 604Ω Nickel/Iron (518) -100°C to +200°C (-148°F to +392°F)	100Ω Platinum (385) -200°C to +850°C (-328°F to +1562°F) 200Ω Platinum (385) -200°C to +850°C (-328°F to +1562°F) 100Ω Platinum (3916) -200°C to +630°C (-328°F to+1166°F) 200Ω Platinum (3916) -200°C to +630°C (-328°F to+1166°F) 120Ω Nickel (618)[4] -100°C to +260°C (-148°F to +500°F) 120Ω Nickel (672) -80°C to +260°C (-112°F to +500°F) 10Ω[5] Copper (426) -100°C to +260°C (-328°F to +500°F)
RTD Type: (Temperature Range Dependent of Excitation Current)[1]	1000Ω Platinum (385): -200°C to +850°C (-328°F to +1562°F) for 0.5 mA excitation. -200°C to +240°C (-328°F to +464°F) for 2.0 mA excitation. 1000Ω Platinum (3916): -200°C to +630°C (-328°F to+1166°F) for 0.5 mA excitation. -200°C to +230°C (-328°F to +446°F) for 2.0 mA excitation. 10Ω[3] Copper (426): -100°C to +260°C (-148°F to +500°F) for 2.0 mA excitation. Important: 0.5 mA excitation current is not allowed for this RTD.	500Ω Platinum (385): -200°C to +850°C (-328°F to +1562°F) for 0.25 mA excitation -200°C to +390°C (-328°F to +698°F) for 1.0 mA excitation 500Ω Platinum (3916): -200°C to +630°C (-328°F to+1166°F) for 0.25 mA excitation -200°C to +380°C (-328°F to +698°F) for 1.0 mA excitation 1000Ω Platinum (385): -200°C to +850°C (-328°F to+1562°F) for 0.25 mA excitation -200°C to +50°C (-328°F to +122°F) for 1.0 mA excitation 1000Ω Platinum (3916): -200°C to +630°C (-328°F to+1166°F) for 0.25 mA excitation -200°C to +50°C (-328°F to +122°F) for 1.0 mA excitation 604Ω Nickel/Iron (518): -200°C to +200°C (-328°F to +392°F) for 0.25 mA excitation -200°C to +180°C (-328°F to +338°F) for 1.0 mA excitation
Resistance Input Types	150Ω for 0.5 and 2.0 mA excitation. 500Ω for 0.5 and 2.0 mA excitation. 1000Ω for 0.5 and 2.0 mA excitation. 3000Ω: 0 to 3000Ω for 0.5 mA excitation 0 to 1900Ω for 2.0 mA excitation	150Ω for 0.25 and 1.0 mA excitation. 500Ω for 0.25 and 1.0 mA excitation. 1000Ω for 0.25 and 1.0 mA excitation. 3000Ω: 0 to 3000Ω for 0.25 mA excitation 0 to 1200Ω for 1.0 mA excitation
Temperature Scale (Selectable)	°C or °F and 0.1°C or 0.1°F	
Resistance Scale (Selectable)	1Ω or 0.1Ω for all resistance ranges, except 0.1 or 0.01 Ω for 150 Ω potentiometer.	
Input Step Response	See channel step response, page 26.	
Input Resolution and Repeatability	See RTD and resistance device compatibility tables on pages 6 through 10.	
Display Resolution	See Channel Data Word Resolution tables on pages 18 and 19.	
Module Update Time	See Update Time, page 26.	

Table 26 Input Specifications

	1746-NR4	1746-NR8
Channel Turn-On Time, Re-configuration Time	Requires up to one module update time plus one of the following: •250 Hz Filter = 388 milliseconds •60 Hz Filter = 1,300 milliseconds •50 Hz Filter = 1,540 milliseconds •10 Hz Filter = 7,300 milliseconds	Requires up to one module update time plus 125 ms times the number of unique input types and excitation current combinations.
Channel Turn-Off Time	Requires up to one module update time.	
RTD Excitation Current	Two current values are user-selectable: • 0.5 mA - Recommended for use with higher resistance ranges for both RTDs and direct resistance inputs (1000Ω RTDs and 3000Ω resistance input). Refer to RTD manufacturer for recommendations. Cannot use for 10Ω Copper RTD. • 2.0 mA - Must use for 10Ω Copper RTD. Recommended to use for all other RTD and direct resistance inputs, except 1000Ω RTDs and 3000Ω resistance input ranges are limited. Refer to RTD manufacturer for recommendations.	Two current values are user-selectable: • 0.25 mA - Recommended for use with higher resistance ranges for both RTDs and direct resistance inputs (1000Ω RTDs and 3000Ω resistance input). Refer to RTD manufacturer for recommendations. • 1.0 mA - Recommended for use with all other RTD and direct resistance inputs, except 1000Ω RTDs and 3000Ω resistance input ranges are limited. Refer to RTD manufacturer for recommendations.

(1) Refer to the current recommendations of the RTD manufacturer to determine the best current source for your application.

(2) Actual value at 0°C is 100Ω per DIN standard.

(3) Actual value at 0°C is 9.942Ω per SAMA standard RC21-4-1966.

(4) Actual value at 0°C is 100Ω per DIN standard.

(5) Actual value at 0°C is 9.942Ω per SAMA standard RC21-4-1966.

Effective Resolution

The effective resolution for an input channel depends upon the filter frequency selected for that channel. The table below provides the effective resolution for the various input types and filter frequencies:

Table 27 Effective Resolution

Input Type[1]	1746-NR4 Filter Frequency				1746-NR8 Filter Frequency			
	10 Hz	50 Hz	60 Hz	250 Hz	28 Hz	50/60 Hz	800 Hz	6400 Hz
100Ω Pt RTD (385)	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.2°C (± 0.4°F)	± 0.4°C (± 0.7°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.2°C (± 0.4°F)	± 0.8°C (± 1.4°F)
200Ω Pt RTD (385)	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.2°C (± 0.4°F)	± 0.4°C (± 0.7°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.2°C (± 0.4°F)	± 0.8°C (± 1.4°F)
500Ω Pt RTD (385)	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.2°C (± 0.4°F)	± 0.4°C (± 0.7°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.2°C (± 0.4°F)	± 0.8°C (± 1.4°F)
1000Ω Pt RTD (385)	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.2°C (± 0.4°F)	± 0.4°C (± 0.7°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.2°C (± 0.4°F)	± 0.8°C (± 1.4°F)
100Ω Pt RTD (3916)	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.2°C (± 0.4°F)	± 0.3°C (± 0.5°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.2°C (± 0.4°F)	± 0.8°C (± 1.4°F)
200Ω Pt RTD (3916)[1]	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.2°C (± 0.4°F)	± 0.3°C (± 0.5°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.2°C (± 0.4°F)	± 0.8°C (± 1.4°F)
500Ω Pt RTD (3916)	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.2°C (± 0.4°F)	± 0.3°C (± 0.5°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.2°C (± 0.4°F)	± 0.8°C (± 1.4°F)
1000Ω Pt RTD (3916)	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.2°C (± 0.4°F)	± 0.3°C (± 0.5°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.2°C (± 0.4°F)	± 0.8°C (± 1.4°F)
10Ω Cu RTD (426) [2]	± 0.2°C (± 0.4°F)	± 0.3°C (± 0.5°F)	± 0.3°C (± 0.5°F)	± 0.4°C (± 0.7°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.2°F)	± 0.4°C (± 0.7°F)	± 1.0°C (± 1.8°F)
120Ω Ni RTD (618) [3]	± 0.1°C (± 0.2°F)	± 0.1°C (± 0.2°F)	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.3°C (± 0.5°F)
120Ω Ni RTD (672)	± 0.1°C (± 0.2°F)	± 0.1°C (± 0.2°F)	± 0.1°C (± 0.2°F)	± 0.2°C (± 0.4°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.3°C (± 0.5°F)
604Ω NiFe RTD (518)	± 0.1°C (± 0.2°F)	± 0.1°C (± 0.2°F)	± 0.1°C (±0.2°F)	± 0.2°C (± 0.4°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.1°C (± 0.1°F)	± 0.3°C (± 0.5°F)
150Ω Resistance Input	± 0.02 Ω	± 0.04 Ω	± 0.04 Ω	± 0.08 Ω	± 0.01Ω	± 0.01Ω	± 0.02Ω	± 0.08Ω
500Ω Resistance Input	± 0.1 Ω	± 0.2 Ω	± 0.2 Ω	± 0.4 Ω	± 0.1Ω	± 0.1Ω	± 0.1Ω	± 0.4Ω
1000Ω Resistance Input	± 0.2 Ω	± 0.3 Ω	± 0.3 Ω	± 0.5 Ω	± 0.1Ω	± 0.1Ω	± 0.2Ω	± 0.6Ω
3000Ω Resistance Input	± 0.2 Ω	± 0.3 Ω	± 0.3 Ω	± 0.5 Ω	± 0.1Ω	± 0.1Ω	± 0.3Ω	± 1.0Ω

(1) The digits following the RTD type represent the temperature coefficient of resistance (a), which is defined as the resistance change per ohm per °C. For instance, Platinum 385 refers to a platinum RTD with a = 0.00385 ohms/ohm-°C, or simply 0.00385/°C.

(2) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(3) Actual value at 0°C is 100Ω per DIN standard.

Channel Step Response

The channel filter frequency determines the channel's step response. The step response is the time required for the analog input signal to reach 100% of its expected final value. This means that if an input signal changes faster than the channel step response, a portion of that signal will be attenuated by the channel filter.

The following table shows the available filter frequencies, associated minimum normal mode rejection (NMR), cut-off frequency, and step response for each filter frequency.

Table 28 Channel Step Response

1746-NR4					1746-NR8				
Filter Frequency	**50Hz NMR**	**60Hz NMR**	**Cut-Off Frequency**	**Step Response**	**Filter Frequency**	**50Hz NMR**	**60Hz NMR**	**Cut-Off Frequency**	**Step Response**
10 Hz	100 dB	100 dB	2.62 Hz	300 ms	28 Hz	110 dB	95 dB	7.8 Hz	120 ms
50 Hz	100 dB	-	13.1 Hz	60 ms	50/60 Hz	65 dB	65 dB	13.65 Hz	68.6 ms
60 Hz	-	100 dB	15.72 Hz	50 ms	800 Hz	–	–	209.8 Hz	3.75 ms
250 Hz	-	-	65.5 Hz	12 ms	6400 Hz	–	–	1677 Hz	1.47 ms

Update Time

The RTD module channel update time is defined as the time required for the module to sample and convert (scan) the input signal of an enabled input channel and make the resulting data value available to the SLC processor for update.

Channel scanning always occurs starting with the lowest numbered channel and proceeding to the next highest numbered channel, for example: channel 0 → channel 1 → channel 2 → channel 3 → channel 0 → channel 1, and so forth. Channel scan time is a function of the filter frequency:

Table 29 Update Time

1746-NR4		1746-NR8		
Filter Frequency	**Channel Scan Time(1)**	**Filter Frequency**	**Channel Scan Time**	**With Lead Resistance**
10 Hz	305 ms	28 Hz	125 ms	250 ms
50 Hz	65 ms	50/60 Hz	75 ms	147 ms
60 Hz	55 ms	800 Hz	10 ms	18 ms
250 Hz	17 ms	6400 Hz	6 ms	10 ms

(1) The module-scan time is obtained by summing the channel-scan time for each enabled channel. For example, if 3 channels are enabled and the 50 Hz filter is selected, the module-scan time is 3 x 65 ms = 195ms.

The *fastest module update time* occurs when only one channel with a 250 Hz filter frequency is enabled.

Module Update Time = 17 ms

NOTE With 3 channels enabled, the module update time is:

3 channels x 17 ms/channel = 51 ms

The *slowest module update time* occurs when four channels, each using a 10 Hz filter frequency, are enabled.

Module Update Time = 4 channels x 305 ms per channel = 1220 ms

Terms and Abbreviations

The following are definitions of some of the terms and abbreviations used in this document:

A/D — Refers to the analog-to-digital converter inherent to the RTD/resistance input module. The converter produces a digital value whose magnitude is proportional to the instantaneous magnitude of an analog input signal.

channel — Refers to each of the small-signal analog input interfaces available on the module's terminal block. Each channel is configured for connection to an RTD or potentiometer input device, and has its own diagnostic status word.

common mode rejection ratio — The ratio of a device's differential voltage gain to common mode voltage gain. Expressed in dB, CMRR is a comparative measure of a device's ability to reject interference caused by a voltage common to its input terminal's relative to ground.

CMRR=20 Log10 (V1/V2)

cut-off frequency — The frequency at which the input signal is attenuated 3dB by the digital filter. Frequency components of the input signal below the cut-off frequency are passed with under 3dB of attenuation.

data word — A 16-bit integer that represents the value of the analog input channel. The channel data word is valid only when the channel is enabled and there are no channel errors. When the channel is disabled, the channel data word is cleared (0).

dB (decibel) — A logarithmic measure of the ratio of two signal levels.

digital filter — A low-pass noise filter incorporated into the A/D converter. In addition, the digital filter provides high-rejection notches at frequencies that are integral multiples of the filter cut-off frequency. The notches are used for rejecting AC power line noise and higher frequency noise.

effective resolution — The amount of jitter (data variation) that typically occurs in the data word due to the influence of the internal electrical noise in the module.

excitation current — A user-selectable current that the module sends through the RTD or resistance device to produce an analog signal which the module can process and convert to temperature or to ohms, respectively.

filter frequency — The user-selectable first-notch frequency for the A/D converter's digital filter. The digital filter provides AC power line noise rejection when the first notch is at 10 Hz or at the power line frequency.

normal mode rejection (differential mode rejection) — A logarithmic measure in dB, of a device's ability to reject noise signals between or among circuit signal conductors, but not between equipment grounding conductor or signal reference structure and the signal conductors.

resolution — The smallest detectable change in a measurement, typically expressed in engineering units (for example, 0.1 °C) or as a number of bits. For example, a 12-bit system has 4,096 possible output states. It can, therefore, measure 1 part in 4096.

RTD (resistance temperature detector) — A temperature sensing element with two, three or four lead wires. It uses the basic characteristic that electrical resistance of metals increases with temperature. When a small current is applied to the RTD, it creates a voltage that varies with temperature. This voltage is processed and converted by the RTD module into a temperature value.

step response time — This is the time required for the A/D input signal to reach *100%* of its expected final value, given a large step change in the input signal.

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